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ABSTRACT

This paper addresses the issue of faculty participation in development programs. Participation in faculty development programs has not been part of the culture in engineering education and with the focus on reform, ways are being sought to involve faculty in retraining. At North Carolina State University (NCSU), representatives from the NSF-sponsored Engineering Education Coalition (EEC) decided to use a faculty development model. Details of this model are presented. (DDR)

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ENGINEERING FACULTY DEVELOPMENT: A MULTICOALITION PERSPECTIVE

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SUCCEED Coalition (2)/ECSEL Coalition (2)/ FOUNDATION Coalition (4)/GATEWAY Coalition

Pressures are building to reform American engineering education, not least of which is the impending adoption of Engineering Criteria 2000 as the default accreditation system. Teaching methods more effective than the traditional chalk-and-talk will be needed to equip engineering graduates with the technical, communication, and interpersonal skills specified in the new criteria, and extensive faculty development will be required to equip engineering instructors to use these methods. Unfortunately, participation in faculty development programs has never been part of the prevalent culture of engineering education.

On April 7, 1999, representatives of the NSF-Sponsored Engineering Education Coalitions met at North Carolina State University to discuss the problem of establishing and sustaining faculty development programs in engineering and attracting widespread faculty involvement in the programs. The participants in this meeting agreed to use a faculty development model currently being developed and implemented by the SUCCEED Coalition[1] as a framework for the ideas collected. The components of the model are shown schematically in Figure 1 and described below, following which faculty development efforts of four coalitions are summarized.

COMPONENTS OF A FACULTY DEVELOPMENT PROGRAM FOR ENGINEERING

Faculty development coordinator

Either a respected engineering faculty member or an education specialist leads the program, is provided with adequate resources to accomplish program objectives, and is held accountable for the program's success or failure. The coordinator is assisted by engineering faculty *teaching leaders* who lead workshops and coordinate teaching discussion/study groups.

Linkages to campus-wide faculty development programs

Engineering FD programs coordinate their activities with campus-wide FD programs to the greatest possible extent. Teaching center personnel participate as co-facilitators in engineering FD programs and encourage and coordinate participation of non-engineering faculty members to help broaden the perspectives of the engineering faculty. The engineering FD coordinator keeps engineering faculty informed about opportunities available to them through the teaching center and other campus-wide programs.

Learning and networking opportunities

- *Teaching workshops* of 1 day or longer and shorter topical seminars are specifically designed for engineering and are organized and facilitated by engineering teaching leaders working collaboratively with campus education specialists.
- *Learning communities* (teaching circles, discussion forums) are formed by groups of two or more faculty members who agree to support one another in their efforts to improve their effectiveness as instructors. Communities may be department- or college-based or campus-wide (there is great value in interdisciplinary contacts among faculty members) and may be organized around specific pre-announced topics, such as a recent paper or book chapter, a specific instructional method or device, or a problem one of the community members wishes to discuss. Activities may also include mutual observation and critiquing of classes, assignments, and tests. Advantage should be taken of external resources on learning community development such as the annual Wakonse Conference and its associated website at the University of Missouri-Columbia.

Programs for new faculty

- *Pre-semester workshops and/or periodic seminars* are offered during the semester to introduce new faculty to student learning styles, basic classroom instructional techniques, learning assessment and evaluation practices (including but not limited to testing and grading), and survival skills.
- *Learning communities* are structured for new faculty members with opportunities for small group discussions, networking, guidance, and support.
- *Mentorships* are organized in which experienced faculty members provide guidance to new faculty members on matters such as planning and effectively presenting courses, starting and building research programs, and balancing the inordinate time demands that are part of every faculty member's life.

Programs for graduate students

- *Orientation workshops and/or periodic seminars* are offered to teaching assistants and graduate students contemplating academic careers, covering topics such as student learning styles, effective lecturing techniques, active and cooperative learning, dealing with common student problems, and survival skills.
- *Mentorships* are organized in which graduate students interested in teaching are paired with experienced faculty to complete short teaching experiences and/or to conduct classroom research investigations.
- *A semester-long course on college teaching* is offered for credit.

Institutional incentives for improving teaching

- *Release time, grants, and consulting assistance* are provided to individuals or groups of faculty members engaged in revising courses or curricula, developing multidisciplinary projects, developing or adapting instructional technology, preparing technology-based course

offerings, carrying out systematic program assessment and evaluation, or conducting classroom research.

- *Travel grants* are awarded to faculty members to attend national and regional conferences and workshops such as the ASEE Annual Conference, the Frontiers in Education Conference, or the National Effective Teaching Institute.
- *Identification and support is given to campus teaching leaders in engineering.* Teaching leaders might be winners of past teaching awards and/or faculty effectively developing or importing innovative instructional techniques. They might be provided with a salary supplement or release time to take a leadership role in faculty development activities on campus, lead a workshop for new faculty, facilitate a monthly teaching circle, or mentor new faculty.
- *A clear administrative message is presented that a commitment to effective teaching is a requirement for tenure and promotion in all faculty positions that involve teaching, and that participation in teaching improvement or professional development programs will be an important indicator of such a commitment.*
- [Optional] *Release time, summer support, or travel or equipment grants are awarded to teaching leaders, mentors, and other faculty members who participate actively in faculty development programs.*

There are alternative viewpoints regarding the last item. Some believe that the more engineering faculty members who are involved in faculty development, the more who will translate what they learn into redesigning courses and curricula, improving their own teaching and eventually serving as mentors to less experienced and knowledgeable colleagues. The argument is that few engineering faculty members will choose to add such activities to their already overcrowded schedules without incentives comparable to the ones already in place for disciplinary research. The proponents of this point of view offer examples of extrinsic incentives leading to sharply increased participation in faculty development workshops, with at least some of the additional participants putting into practice methods presented at the workshops.

Others argue that if faculty development activities become part of every faculty member's regular work week and the faculty members belong to a supportive community of learners, then participating in the activities can constitute its own reward with no need for external or extrinsic incentives. In fact, offering external rewards may send a mixed message that professional development is something outside the faculty members' "real" job, and the resulting changes do not affect their core roles. Some also feel that if more faculty members get involved in a broad spectrum of faculty development opportunities, the possibilities to change expand, more will translate what they learn into redesigning courses and curricula, they will focus on improving their own teaching, and eventually serve as mentors to other interested colleagues. Heavy workload is a chronic problem in all disciplines of academia; it is not just limited to engineering. Therefore, efforts to create such intrinsic motivation are difficult, at best, to achieve on a large scale. There are examples, however, where a relatively small group of highly motivated faculty from across campus have volunteered their time to improve their own teaching, serve as mentors to others, and create fairly large scale organizational change in the College of Engineering as well as at the institutional level.[2] In sum, both viewpoints of supporting intrinsic as well as

extrinsic rewards have merit, so the inclusion of rewards for participation in faculty development is left as an option in the SUCCEED model.

Program Assessment and Evaluation

Once an engineering faculty development program has been initiated, continued support to maintain it should be contingent on clear demonstrations of its effectiveness. Each program element must be assessed and evaluated on a continuing basis. Various assessment methods should be used, including recording levels of faculty participation, collecting participant evaluations of workshops and seminars, administering follow-up surveys to participants and monitoring changes in their teaching practices and student ratings, and analyzing data from periodic assessments of faculty teaching practices and perceptions about institutional support of teaching. Felder *et al.*[3] offer a model for such an assessment instrument.

FACULTY DEVELOPMENT IN THE ENGINEERING EDUCATION COALITIONS

ECSEL Coalition

Since 1995, one of ECSEL's major goals has been the development of faculty, particularly those from under-represented populations such as women and ethnic minorities. The primary objectives of the faculty development program are to engage veteran and young faculty in ECSEL's theme of learning by design; to deal with diversity issues; to improve the prospects of young faculty for success; and to change the tenure and promotion process.

- In 1996 a four-day workshop was held at Penn State for young faculty and graduate students from ECSEL schools and nine other universities from outside the coalition. The workshop topics included basics of course design, research funding and proposal writing, and time management. A Junior Faculty Development Workshop was held at the 1997 ASEE Annual Conference. A Teaching Strategy and Engineering Curriculum Transformation Workshop given at the University of Maryland addressed such topics as the impact of ABET 2000 on course development, the integration of cooperative learning teaching models, development of an inclusive classroom, and the development of student-friendly syllabi.
- "In Their Own Words," a video and accompanying workshop that addresses student experiences in the classroom and how to enhance the student learning environment, is under continuing development. The video will be tailored to fit the demographics of each of the ECSEL campuses. On May 11, 1999 Penn State conducted a training program for facilitators of the video workshop. Twenty-one participants (including deans, department heads, and other administrators) representing each of the coalition schools were present, and copies of the video were distributed. The training is crucial to the successful use of the video, which is not a standalone product. The new version of the video should be ready by April 2000, in time for viewing during the next training program at Penn State.
- A two-day ECSEL/MIT dissemination workshop took place on April 30–May 1, 1999 at MIT, with representation from universities throughout the country. The workshop objectives were (1) to transfer the best practices of ECSEL to other schools both in and outside of the coalition, (2) to learn about the efforts of other coalitions and individuals involved in curriculum reform, learning by design, and faculty development, and (3) to write a joint

paper that will both identify the barriers to reform and propose possible solutions. Each of these objectives has been met.

- Upper level undergraduate students are recruited for service *as undergraduate teaching fellows* (UTF). These students enroll in a one-credit course in pedagogy, teaching methods and team building strategies and are assigned to co-teach with a faculty member in first-year design courses. The fellows provide in-class demonstrations of effective teaching strategies and serve as agents of change for the faculty. Faculty report changing their style and methods based upon things they learned from the UTFs.[4]
- Graduate/Faculty Lunch Seminars feature panel discussions by faculty women, alumnae and other invited speakers on career development and success issues for graduate women.
- Directories of women faculty and graduate students and of Black, Hispanic, and Native American engineering faculty have been published. The latter volume includes faculty from member institutions in the ECSEL, Foundation, Gateway, SUCCEED, and Synthesis coalitions. MIT has committed to maintain the directory in perpetuity.

Faculty across the coalition were surveyed about their involvement in teaching reform efforts and their attitudes regarding the issues addressed in the faculty development program objectives. Relative to their colleagues who have not been involved with ECSEL, participating faculty members were more likely to report increases in reading education journals (36% vs. 16%), submitting manuscripts to education journals (28% vs. 11%), attending education conferences (46% vs. 19%), discussing teaching with colleagues (74% vs. 50%), interacting with faculty from other engineering disciplines (69% vs. 47%), and being sensitive regarding the educational needs of women (39% vs. 10%) and underrepresented groups (35% vs. 12%).

FOUNDATION Coalition

The principal goal of the Foundation Coalition has been to develop and institutionalize integrated first-year and second-year engineering curricula at all coalition campuses. The focus of coalition faculty development effort has been a series of workshops presented beginning in 1994. All workshops are delivered by the teaching faculty, the coalition provides materials, and the office of the Dean of the presenting campus provides some of the logistical support (invitations, etc). All faculty teaching in freshman and sophomore programs are strongly encouraged to participate in the workshops.

Beginning in 1998, the freshman and sophomore faculty planned and delivered their own set of workshops, adapting material developed by the coalition to their own campuses and subject matter. For example, the faculty teaching in the Texas A&M engineering science core courses used examples from their classes to demonstrate the use of active/collaborative learning and effective use of technology. Coalition leaders still attend the workshops and in some cases help facilitate the discussion.

The following workshops have been given.

- *Teaming and Collaborative Learning.* Basic and advanced concepts in the use of active and collaborative learning in the classroom. Dozens of examples are introduced to the audience

based on the experiences of coalition faculty. The workshop also illustrates the development of a tutorial for teaching teaming skills to students.
Target Faculty: Engineering, Mathematics, Science, English. Duration: 8 hours.

- *Technology-Enabled Education.* Uses of computers to enhance student learning experiences and to promote teaming and active learning in the classroom.
  Target Faculty: Engineering, Mathematics, Science. Duration: 4 hours.
- *Curriculum Integration.* Integration of the basic disciplines in the freshman engineering program—namely, math, chemistry, physics. engineering problem solving, engineering design graphics, and English. The methodology used in the design, development and implementation of the Foundation Coalition freshman integrated pilot. Four successfully implemented modules are used to demonstrate the effectiveness of integration: (1) ethics, (2) curve-fitting, (3) conservation and accounting, and (4) statics.
  Target Faculty: Engineering, Mathematics, Science, English. Duration: 4 hours.
- *Conservation and Accounting Framework.* Basic concepts of the conservation and accounting framework used in the development of the second-year integrated curriculum. The use of the framework to formulate and solve problems related to the engineering sciences (statics, dynamics, thermodynamics, electrical systems, etc.) is illustrated with examples from the integrated curriculum.
  Target Faculty: Engineering (mostly), but Mathematics, Science and English faculty are welcome to attend. Duration: 4 hours.
- *Assessment and Evaluation.* Outcome-based assessment methodologies. Development of learning objectives for specific courses and of an assessment plan for these objectives.
  Target Faculty: Engineering, Mathematics, Science, English. Duration: 4 hours.
- *Change Management and Institutionalization.* The Coalition Institutionalization Team developed 11 case studies based on actual situations at partner campuses. The basic elements of change management are discussed, following which participants define for each case study: (1) barriers to implementation, (2) potential change agents, and (3) strategies for institutionalization. Each faculty team develops an action agenda.
  Target Faculty: Engineering, Mathematics, Science. Duration: 4 hours.

A program called *Creating a Collaborative Learning Environment* (CCLE) was developed at the University of Wisconsin, beginning as a dissertation study in the College of Engineering. Among the products developed by program participants is a freshman engineering design course based on a model of collaborative teaching and learning for both students and faculty. The course involves a semester-long project in which student teams design, build, and deliver a product to a real customer in the community. The success of this course—and of CCLE—is largely due to the unique model upon which CCLE is based (weekly small group meetings of 1.5 hours a week for an academic year to focus on *learning* rather than teaching). As of April 1999, CCLE had involved 131 faculty from 55 departments. CCLE's participatory structure has been expanded to develop a leadership institute, a new pilot program for research and development, and a center called *Creating a Collaborative Academic Environment* (CCAE). CCAE programs include a learning community for multidisciplinary collaboration in teaching, research, and service, a peer review program, and a teaching/learning colloquium series.

GATEWAY Coalition

Gateway Coalition faculty development efforts have primarily focused on integrating outcomes assessment and technology into the educational process. Many of the coalition's initiatives, interventions, and developmental workshops have been designed to enhance the use of these two educational tools. The faculty development program has several components:

- *Gateway Day*. A coalition-wide activity in which professional development needs are established in faculty focus groups.
- *Assessment Sessions*. Sessions are held on (a) defining departmental objectives, strategies, outcomes, and assessment processes (targeted at administrators, curriculum and accreditation committee members, and key faculty), (b) defining course objectives, strategies, outcomes, and assessment procedures (targeted at all faculty), and (c) creating assessment processes for the classroom (targeted at faculty and assessment coordinators).
- *Technology/Pedagogy Sessions*. Each campus provides workshops and seminars on learning theory-based educational technologies.
- *Partnerships*. Linkages are established to colleges of education, industries, information systems departments, and library services.
- *Student Technology Assistants*. Formalized agreements are made between students with high levels of computer skills and faculty members to develop the faculty's proficiency in the use of new learning technologies.

To assess the effectiveness of the faculty development program, the coalition has incorporated two assessment processes. The first is the development of a series of institutional metrics. For faculty development and related areas of outcomes-based assessment and instructional technologies, coalition staff and faculty from each of the member institutions defined 12 discrete metrics. Several key faculty from each institution are polled annually to reach a consensus on the quantification of each metric. For example, faculty are asked to quantify "the number of undergraduate lower division courses that use multimedia or internet-based materials to supplement student learning."

The second assessment process is the 63-item Faculty Technology Survey, which is designed to collect faculty self-report data on several areas related to their developing knowledge and use of instructional technologies in and out of the classroom. The survey's focus areas include current skill levels on a variety of instructional technologies, degree of use of the technologies in the classroom, and desires regarding future skill development and use. Last year, the coalition administered the survey to over 130 faculty across seven schools to collect baseline information. The plan is to administer the survey every two years to participating faculty.

SUCCEED Coalition

As of Fall 1999, implementation of the SUCCEED faculty development model (Figure 1) on the coalition campuses has proceeded as follows.

- **Faculty development coordinator.** A faculty development coordinator's position has been

established in the College of Engineering at Georgia Tech, and a funded faculty development committee has been established at Clemson. At the other SUCCEED campuses, FD coordination is still done by an individual funded by SUCCEED, but the plan is for institutionalization of the position when SUCCEED funding ends.

- **Linkages to campus-wide faculty development programs.** Extensive coordination of activities between engineering faculty development leaders and campus teaching centers is in place at Clemson, Georgia Tech, North Carolina State, the University of Florida, and Virginia Tech. The other three campuses either have no campus teaching centers or established one too recently for coordination to be put in place.

- **Learning and networking opportunities.** All of the SUCCEED campuses have hosted workshops on effective teaching and on specific teaching-related topics. Periodic meetings of interested faculty to discuss education-related topics and to share problems and experiences are held at Clemson, Georgia Tech, North Carolina State, the University of North Carolina at Charlotte, and Virginia Tech.

  Teaching Effectiveness Workshops. Two-day Coalition-wide workshops were held at Georgia Tech on Oct. 2-3, 1997 for 57 faculty and at FSU/FAMU on October 22-23, 1998 for 64 faculty. Topics covered included learning styles, instructional objectives, activities for the first week of class, test construction, grading, lecturing, cooperative learning, and other problems facing faculty.

  Student Success Workshop. A two-day Coalition-wide workshop was presented to 43 participants at UNC-Charlotte on February 12-13, 1998. Topics included current research on student attrition from engineering, effective techniques for teaching first-year students, and integrated curricula.

  Effective Teaching with Technology. A day-long Coalition-wide workshop was held at Clemson February 19, 1999 for 57 participants. Topics included learning styles, instructional objectives, integration of instructional software into the learning environment, using the Web, and distance education. A training workshop for 22 participants was held on February 20 to prepare teaching leaders to present technology workshops.

  Teaching Leader Network. Teaching leaders have been identified on each campus and have been involved in an online listserver and training events.

- **Programs for new faculty.**

  Orientation to Teaching Workshops. A day-long Coalition-wide workshop was held at NC State University on April 3, 1998 for 102 participants. Immediately following the workshop, a training event was held to prepare nineteen engineering teaching leaders to present similar workshops on their own campuses. To date, workshops based on the model have been presented by local teaching leaders at NC State University, Clemson University, FAMU-FSU, and the University of Florida.

  Mentoring and Supporting New Faculty. A half-day workshop for deans, department chairs, and senior faculty was developed for presentation on each SUCCEED campus. Topics include research on new faculty stress and work patterns, models for mentoring, the role of the department chair, and incentives and rewards. In the Fall 1999 semester, workshops were held at Clemson and at North Carolina State.

- **Programs for graduate students.** Teaching workshops for graduate students (teaching assistants and students contemplating academic careers) are held at Georgia Tech, North Carolina State, and the University of Florida. At other campuses graduate students are invited to participate in the workshops for faculty.
- **Institutional incentives for improving teaching.** All of the campuses have teaching awards and most campuses provide funds for travel to ASEE conferences. Institutionalization of other measures is a strong priority for the remaining years of the coalition. A compilation of incentives and rewards has been developed and distributed to faculty throughout the coalition.

Assessment of the faculty development program has several components. Attendance at all coalition-wide and local campus FD events is monitored, and a master list is being compiled of participating faculty members. The goal is to achieve a coalition-wide participation of 60% of all full-time faculty members. The quality of each event is also assessed by means of a written evaluation form.

The principal vehicle for assessment of the faculty development program is a coalition-wide survey on faculty teaching practices and attitudes about the campus climate for teaching.[3] The survey was administered in 1997 and 1999, and will be administered for a third time in 2001. Observed trends in the use of active and cooperative teaching methods and instructional technology will provide a measure of the effectiveness of coalition efforts to promote these approaches. Similarly, perceptions of the importance of teaching performance in the faculty incentive and reward system will indicate whether or not the coalition is succeeding in its goal of improving the campus climate for teaching.

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Figure 1. SUCCEED Faculty Development Model[1]

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